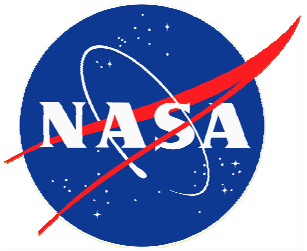
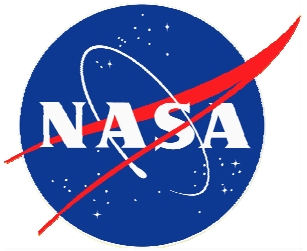


Future Challenges Facing SEE Pulsed Laser Technique

Stephen Buchner,
QSS Group Inc/NASA GSFC
Dale McMorrow,
Naval Research Laboratory

Presented by S. Buchner at SEE Symposium,
Long Beach, CA April 11th, 2006

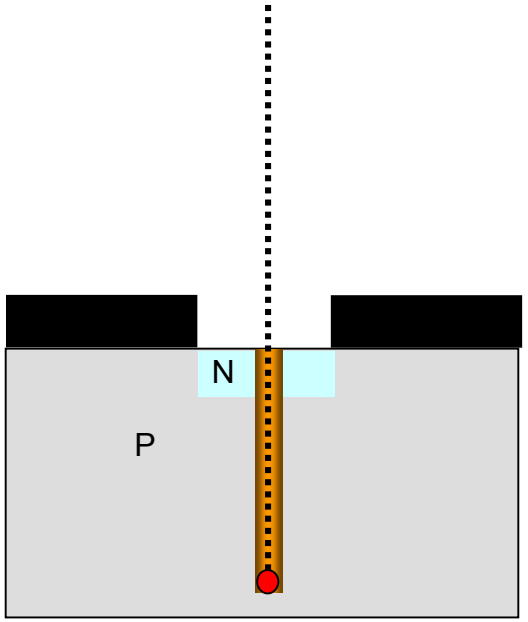


What is the Basic Mechanism Behind Single Event Effects?

CHARGE INJECTION

Presented by S. Buchner at SEE Symposium,
Long Beach, CA April 11th, 2006

Charge Injection
by Ion Beam



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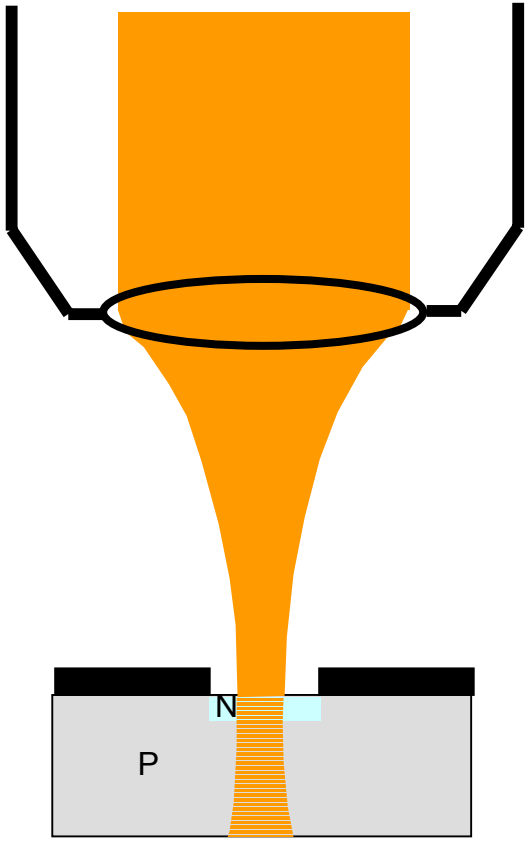
Charge Injection by Pulsed Focused Laser Beam



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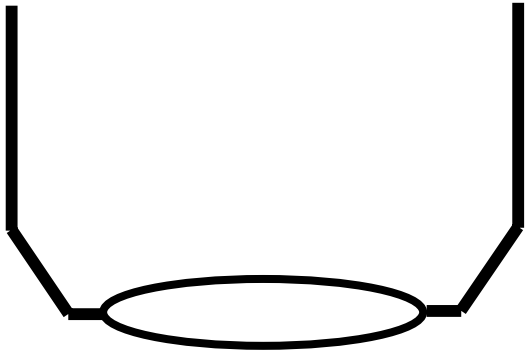
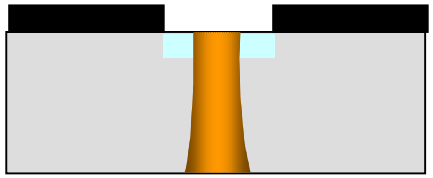
Charge Injection by Pulsed Focused Laser Beam





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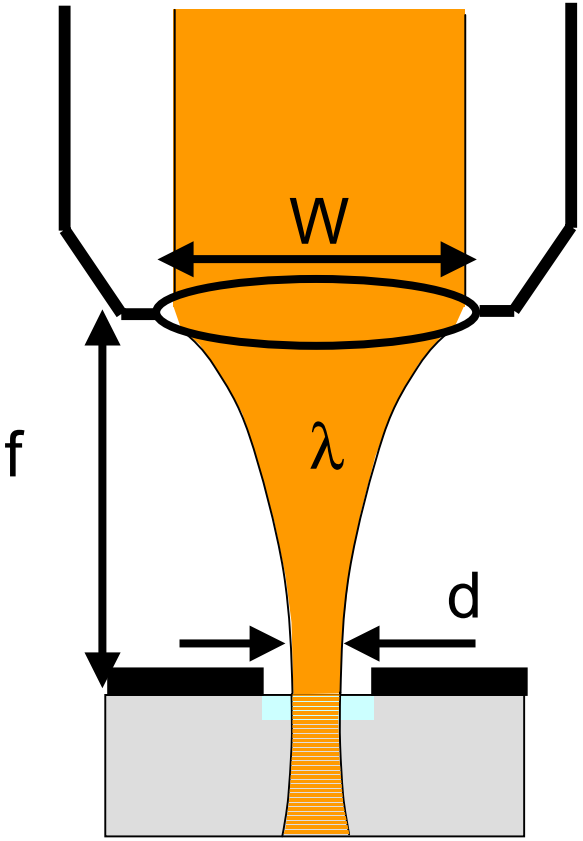
Charge Injection by Pulsed Focused Laser Beam

$$d = \frac{2.44\lambda f}{w}$$



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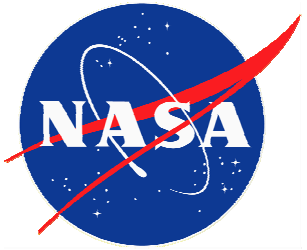
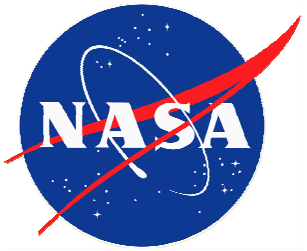
Requirements



- Light must be able to reach sensitive nodes
  - Metal layers and packaging
- Light must be able to create free carriers
  - Materials and structures

Preferences

- Sensitive node must be “visible”
  - Scaling
- Amount of absorbed light must be measurable
  - Quantifiable



Future Challenges

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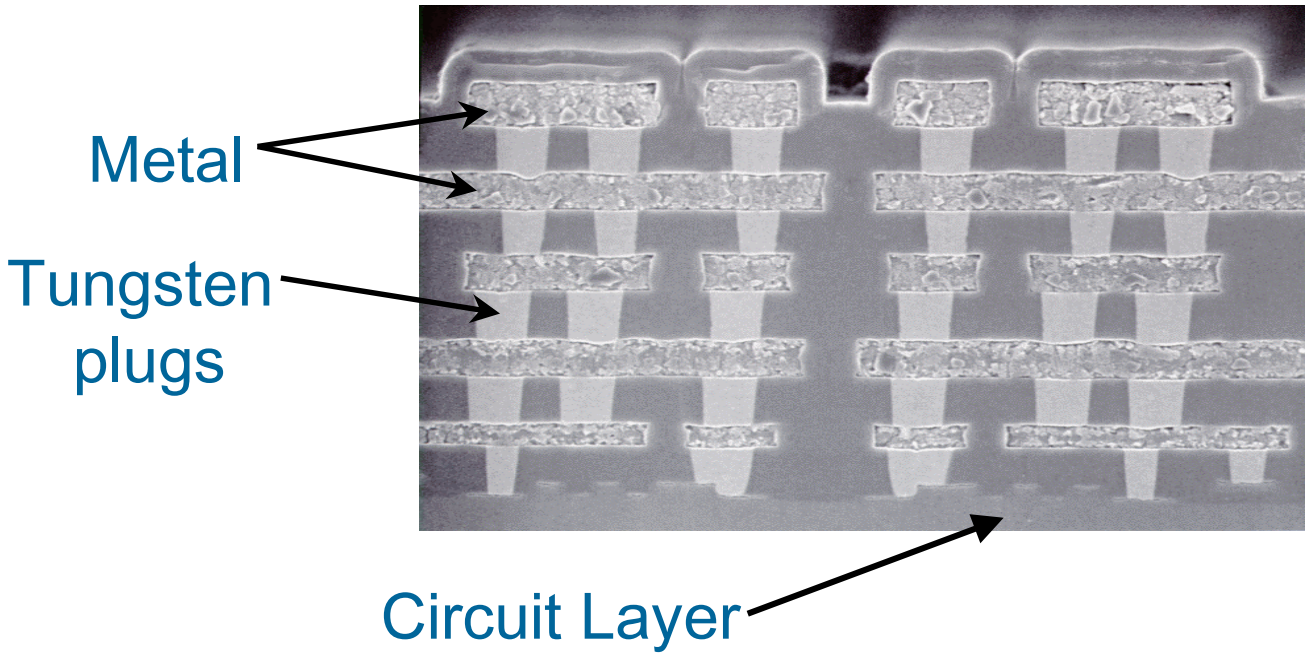
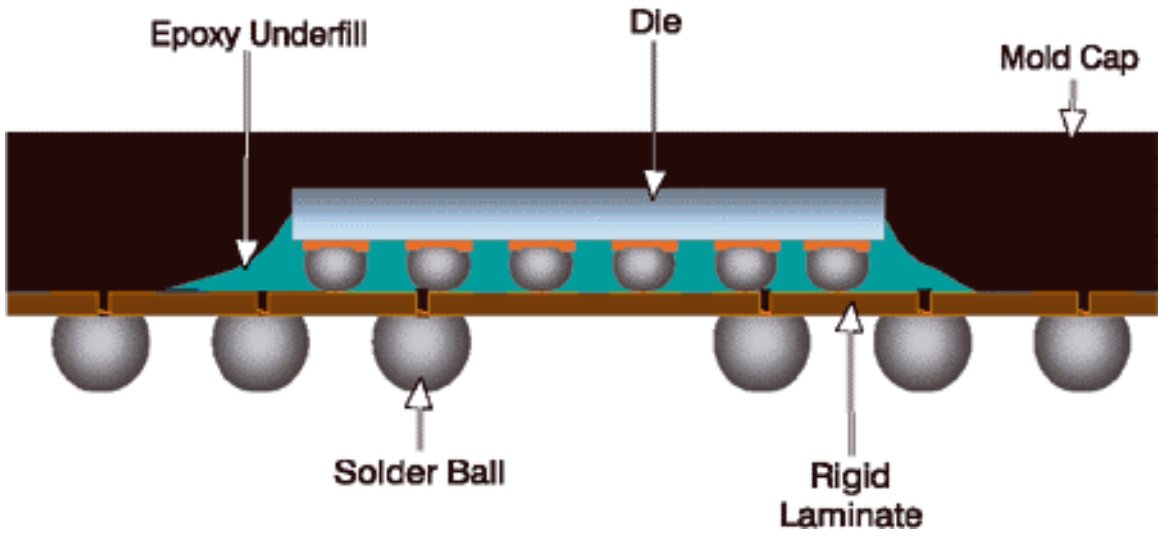
Future Challenges

- **Metallization**



Future Challenges

- Metallization
- **Packaging**



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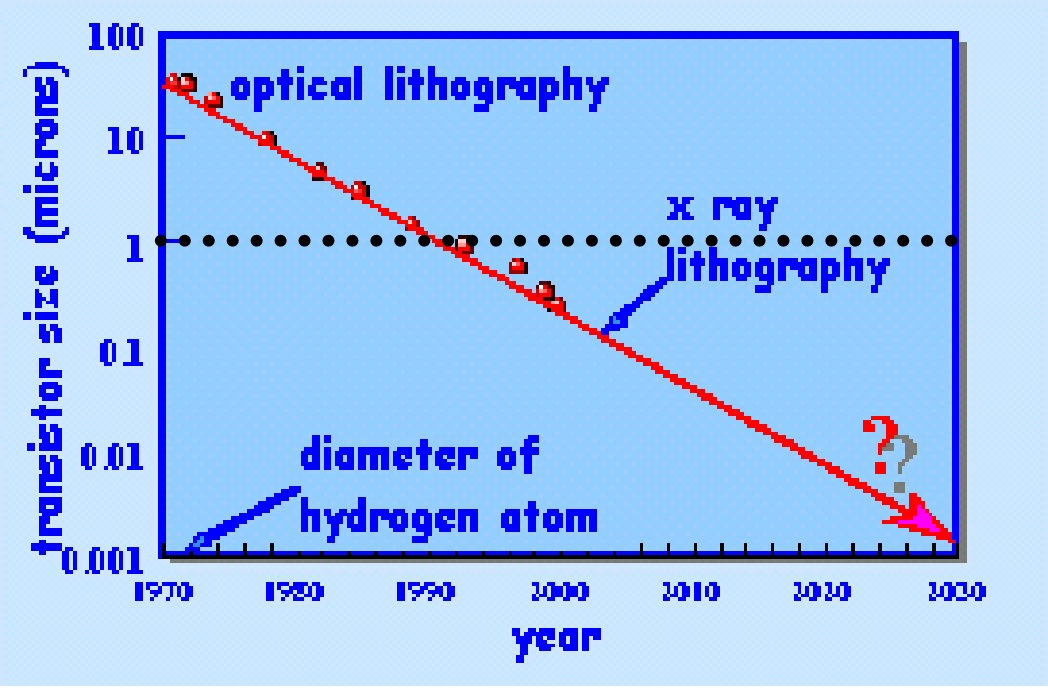
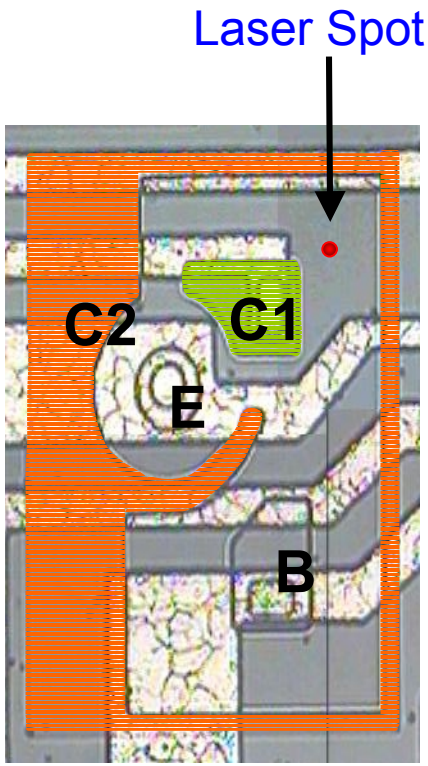
Future Challenges

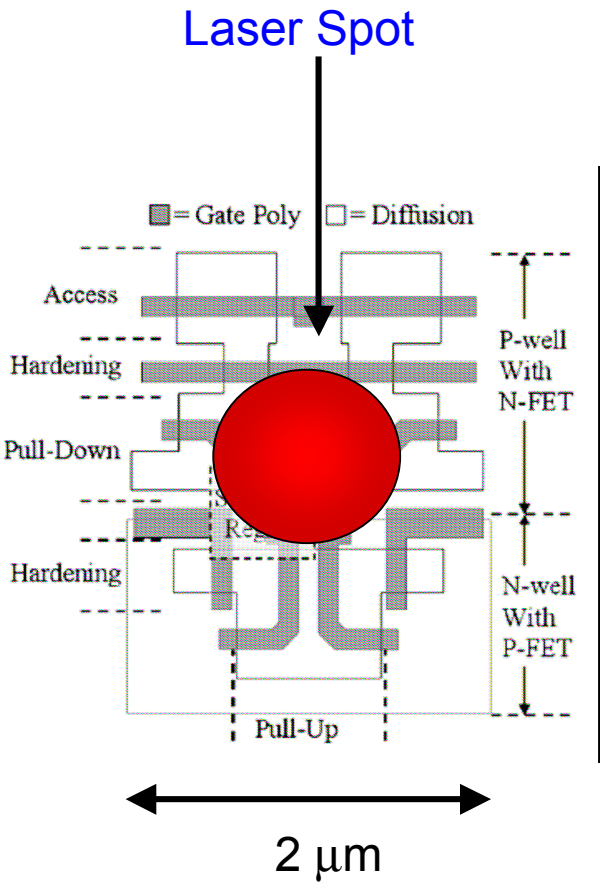
- Metallization
- Packaging
- **Scaling**



Future Challenges

- Metallization
- Packaging
- **Scaling**





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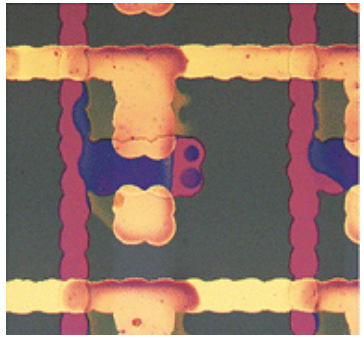
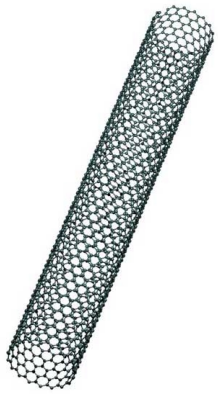
Future Challenges

- Metallization
- Packaging
- Scaling
- **Exotic Materials**

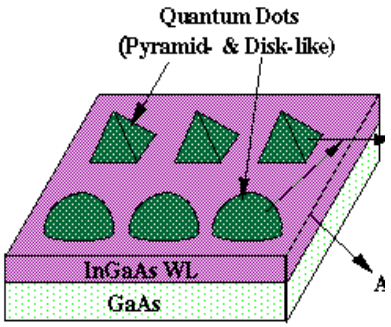
Plastic Transistor

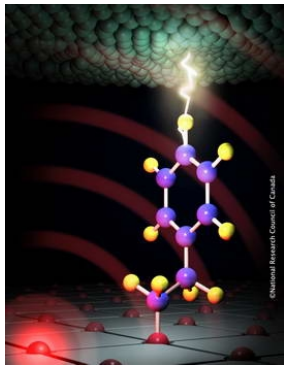




Carbon Nanotubes

Quantum Dots





Single Molecule Transistor

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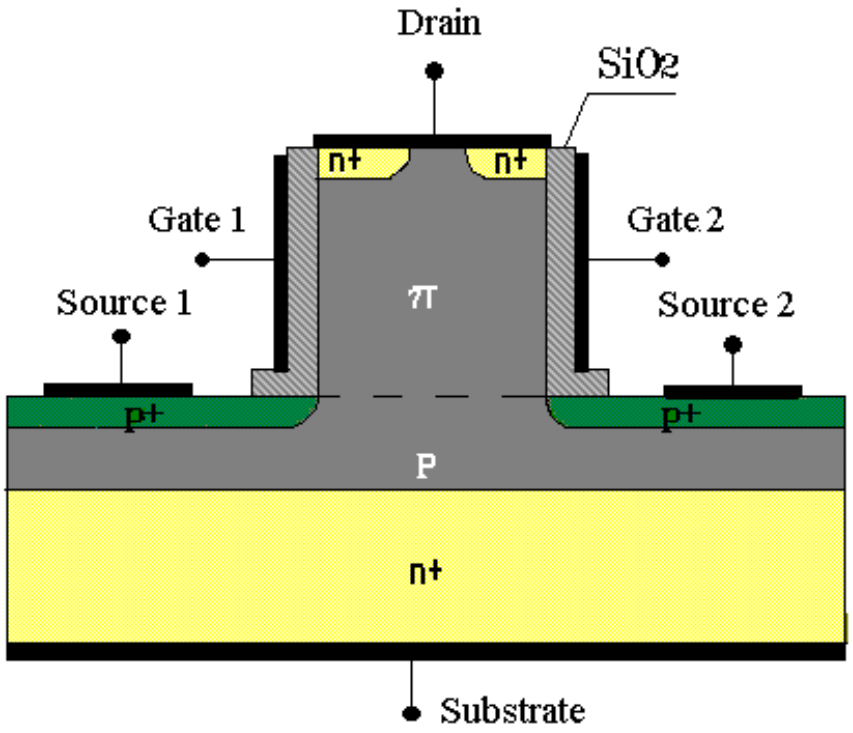
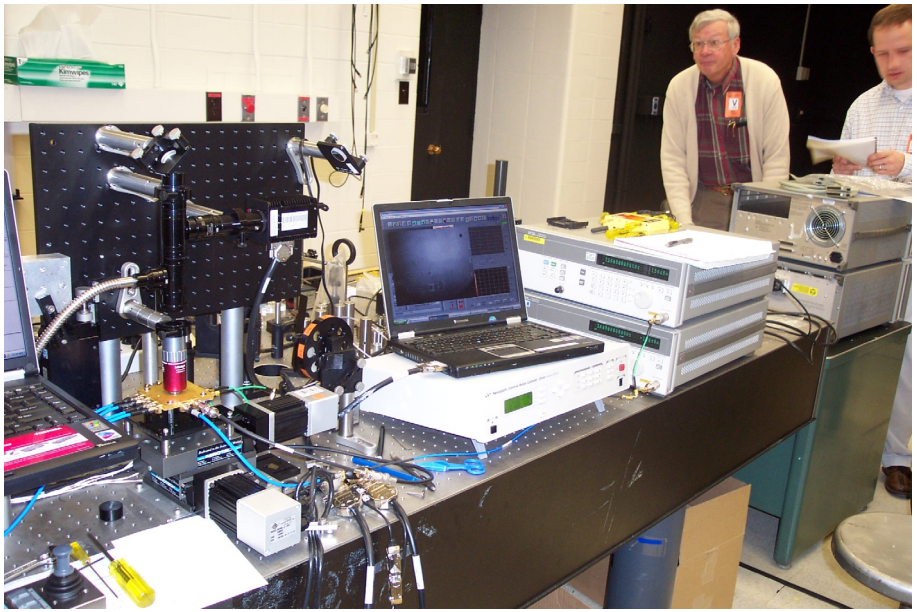
Future Challenges

- Metallization
- Packaging
- Scaling
- Exotic Material
- **Novel Structures**



Future Challenges

- Metallization
- Packaging
- Scaling
- Exotic Material
- Novel Structures
- **Equipment**



$$ for Lasers

Large Optical Table

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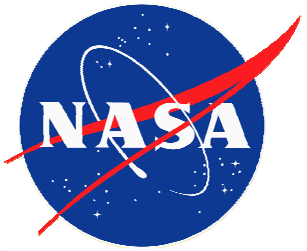

Current State of Technique

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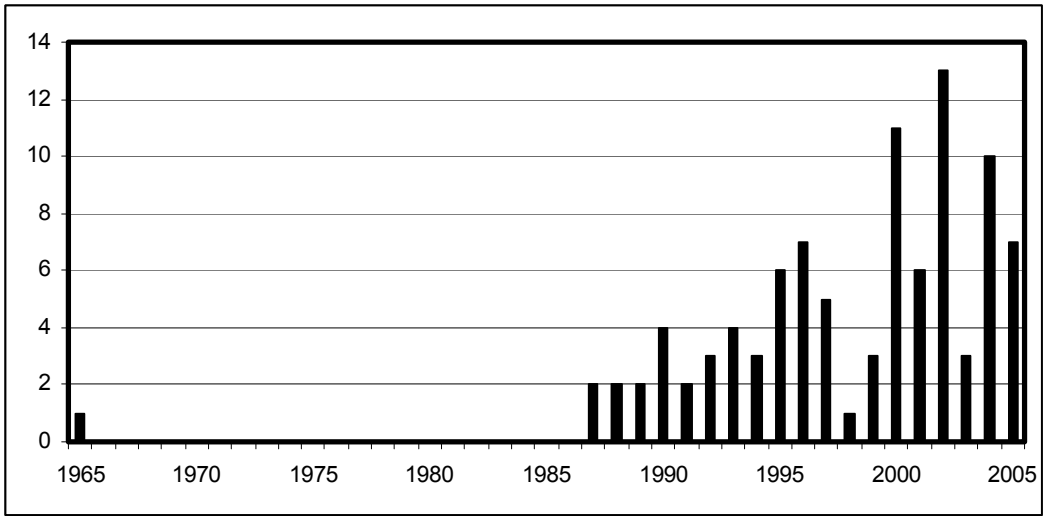
>100 Papers



Major US Sponsor: DTRA

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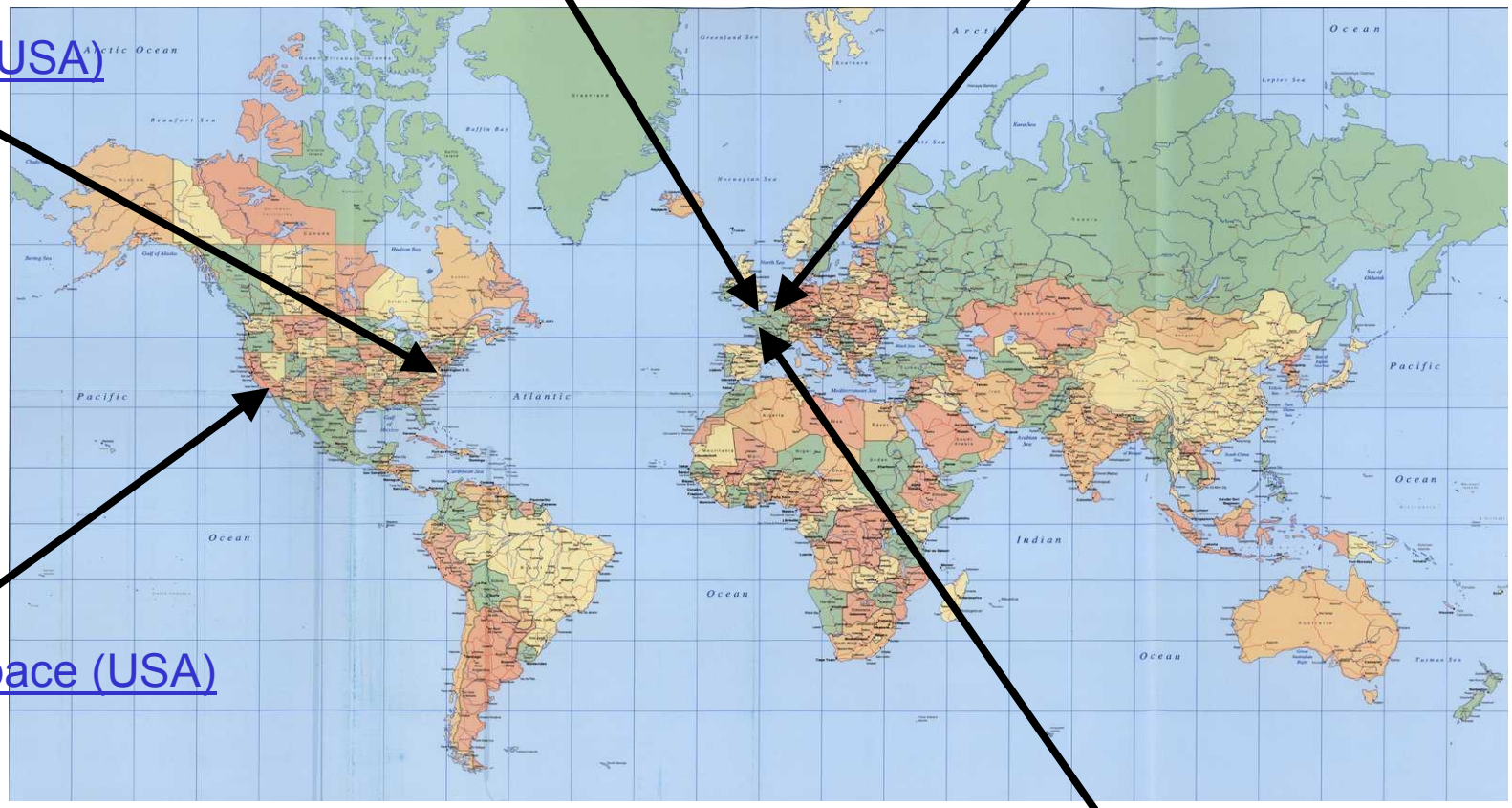
5 Facilities

MBDA (England)

European Aeronautic Defense & Space Company (France)

NRL (USA)



Aerospace (USA)

IXL (France)

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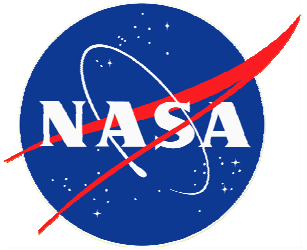
Pulsed Laser Can Produce …



- **Single Event Transient (SET)**
- **Single Event Upset (SEU)**
- **Single Event Latchup (SEL)**
- **Single Event Snapback (SES)**
- **Dose Rate (γ-dot)**

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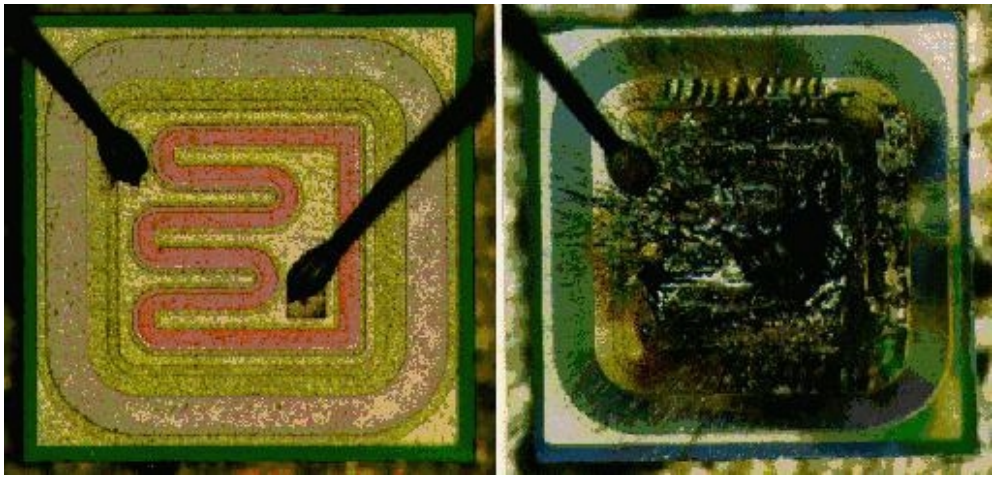
Pulsed Laser Not Practical for….

- **Single Event Gate Rupture**
- **Single Event Burnout in Power MOSFETs**



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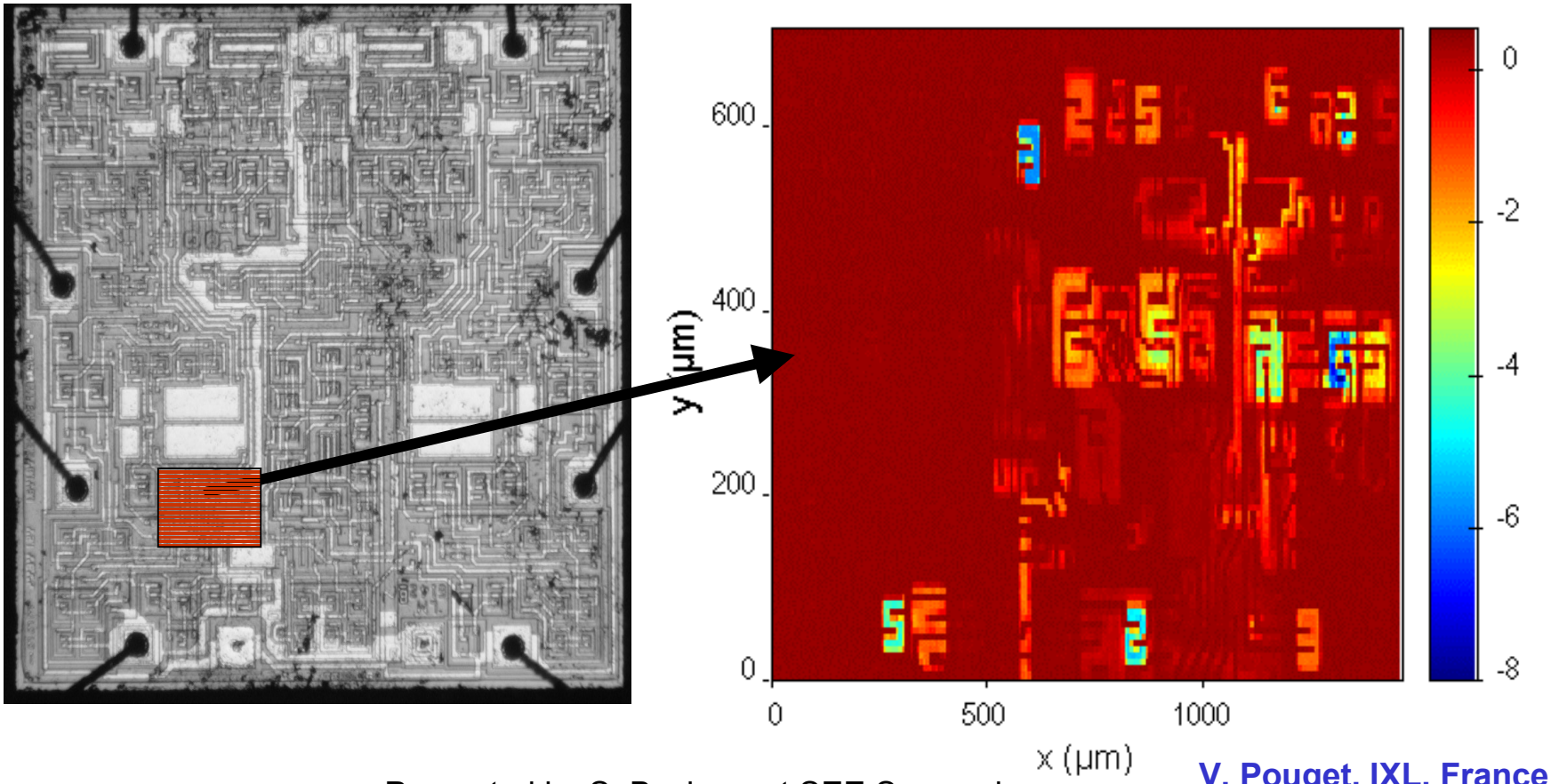
Spatial Information



V. Pouget, IXL, France

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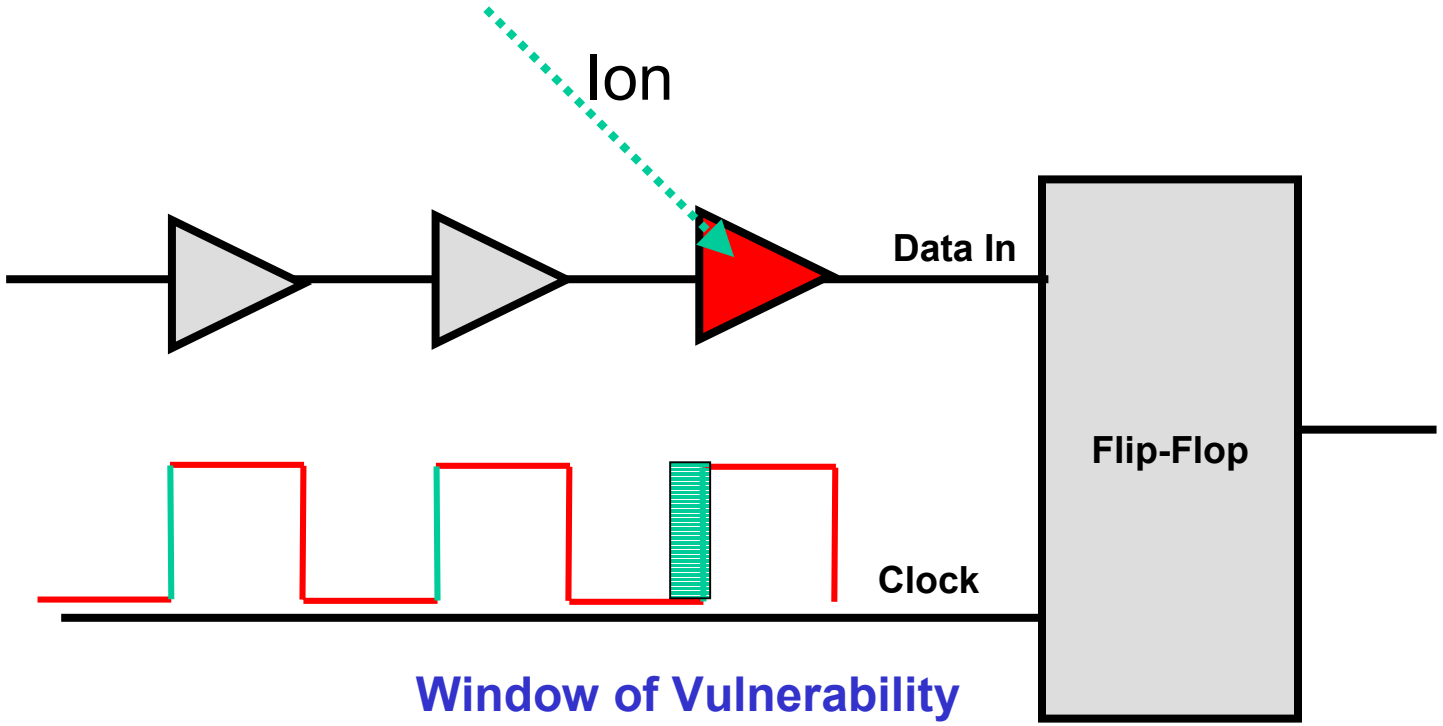
Temporal Information



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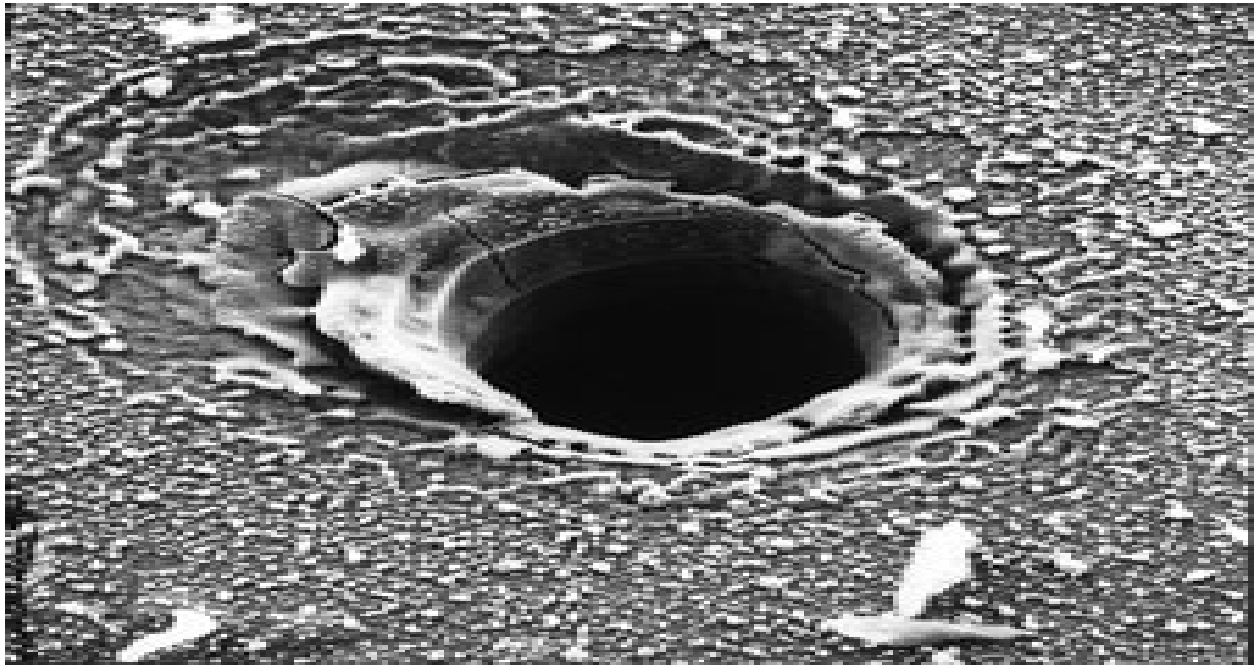
Very High LET

LET >> 100 MeV.cm^2/mg
Limited by material damage



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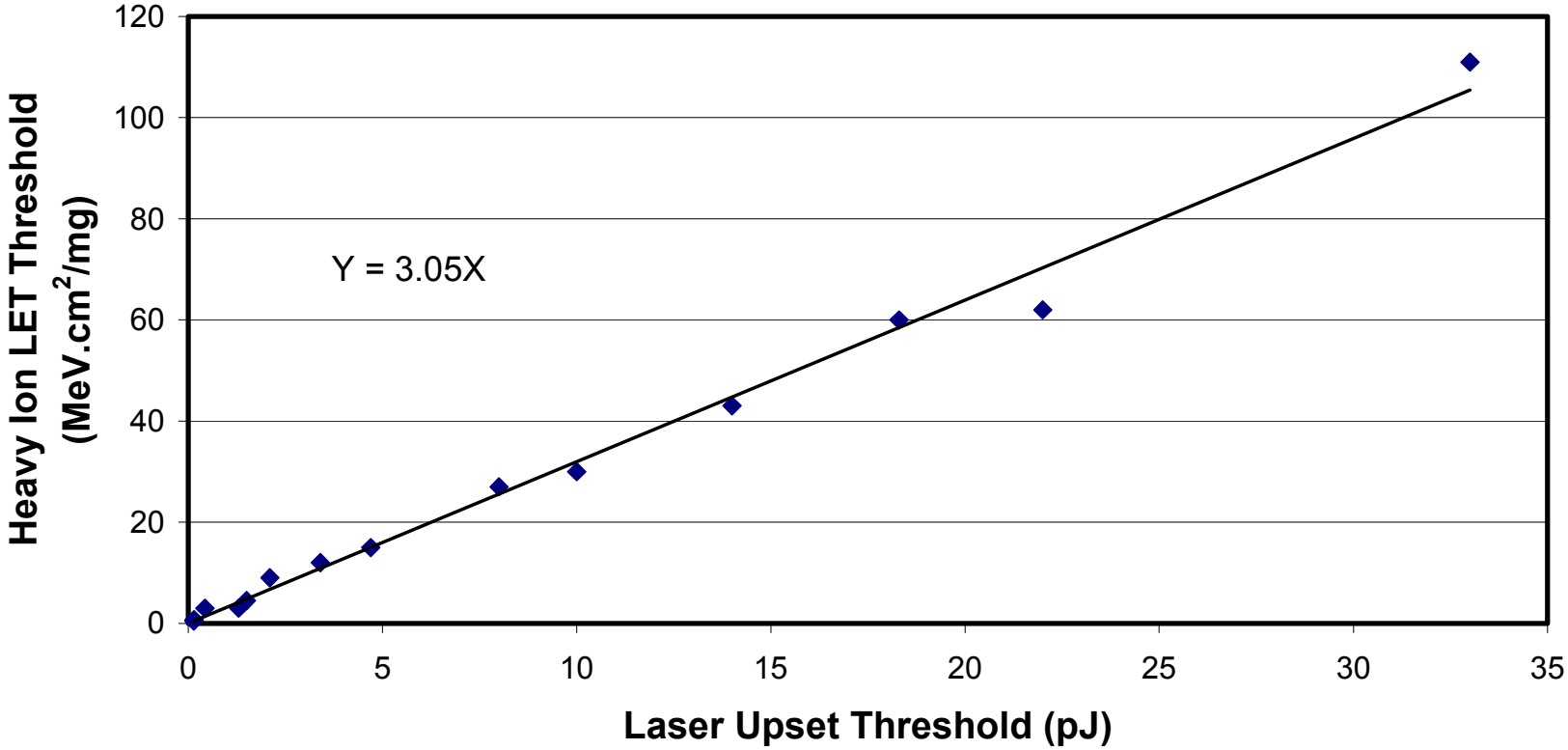
Ion LET Threshold from Laser Energy Threshold?



L=590 nm

McMorrow IEEE TNS 2000

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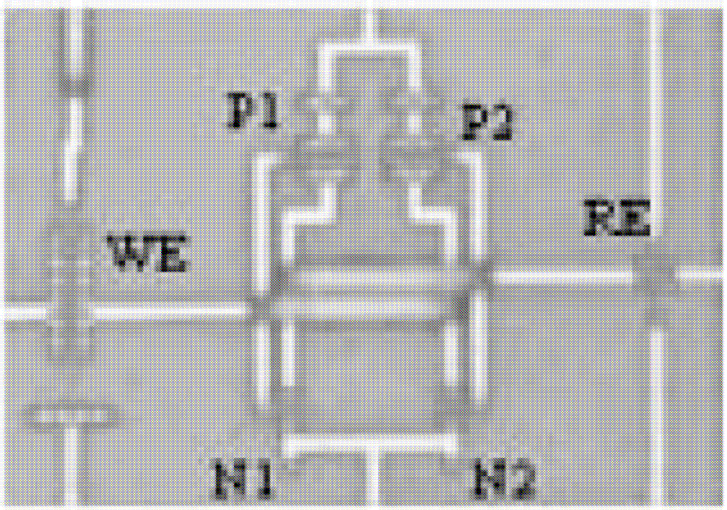
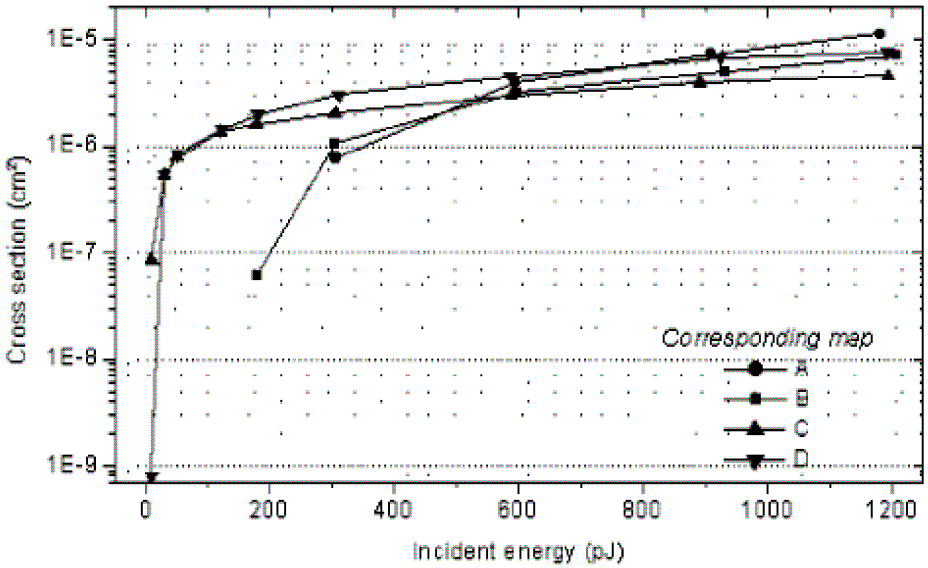
Cross-Section





- **No metal.**
- **Large structures.**

V. Pouget, IXL, France

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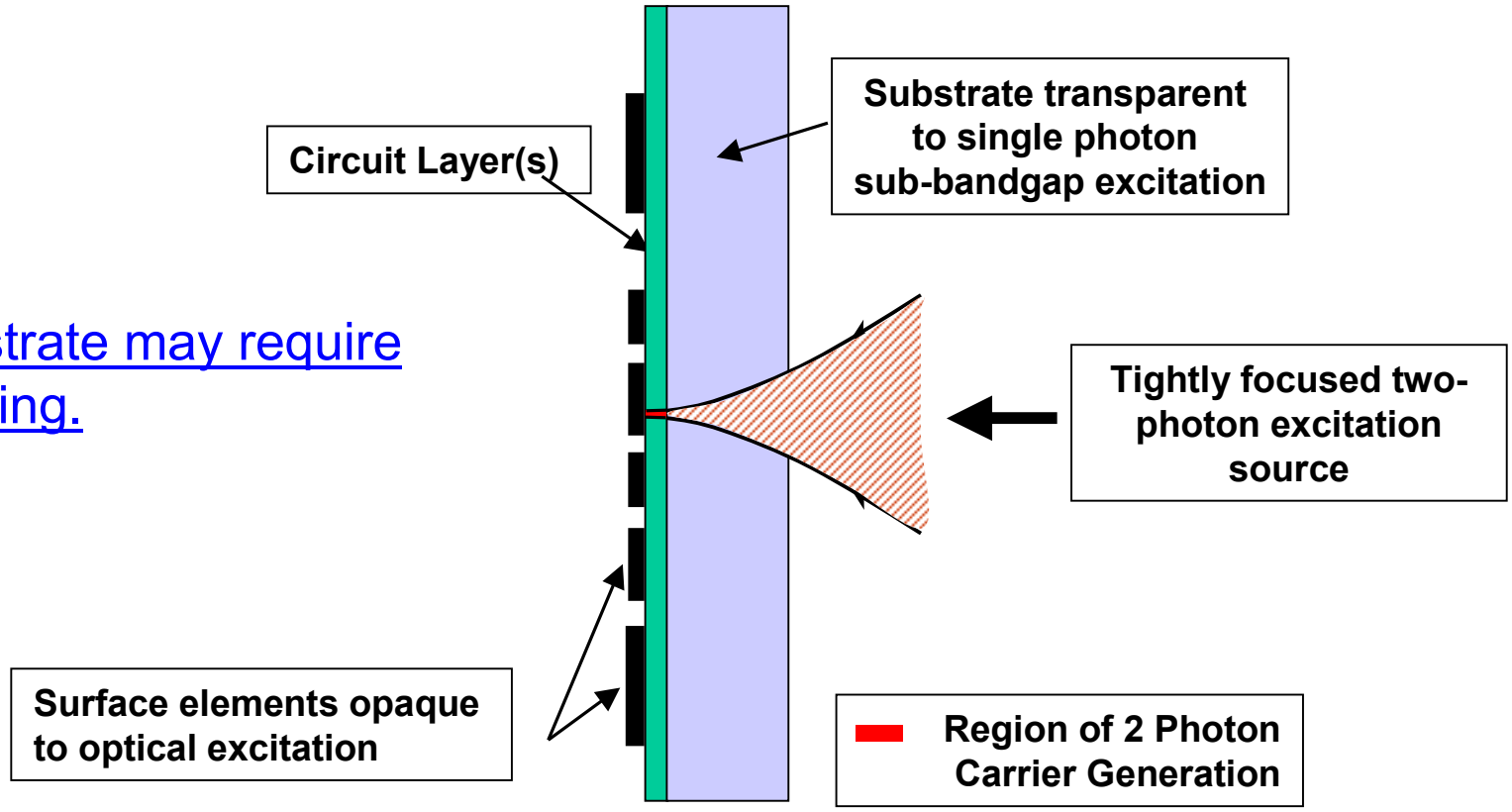
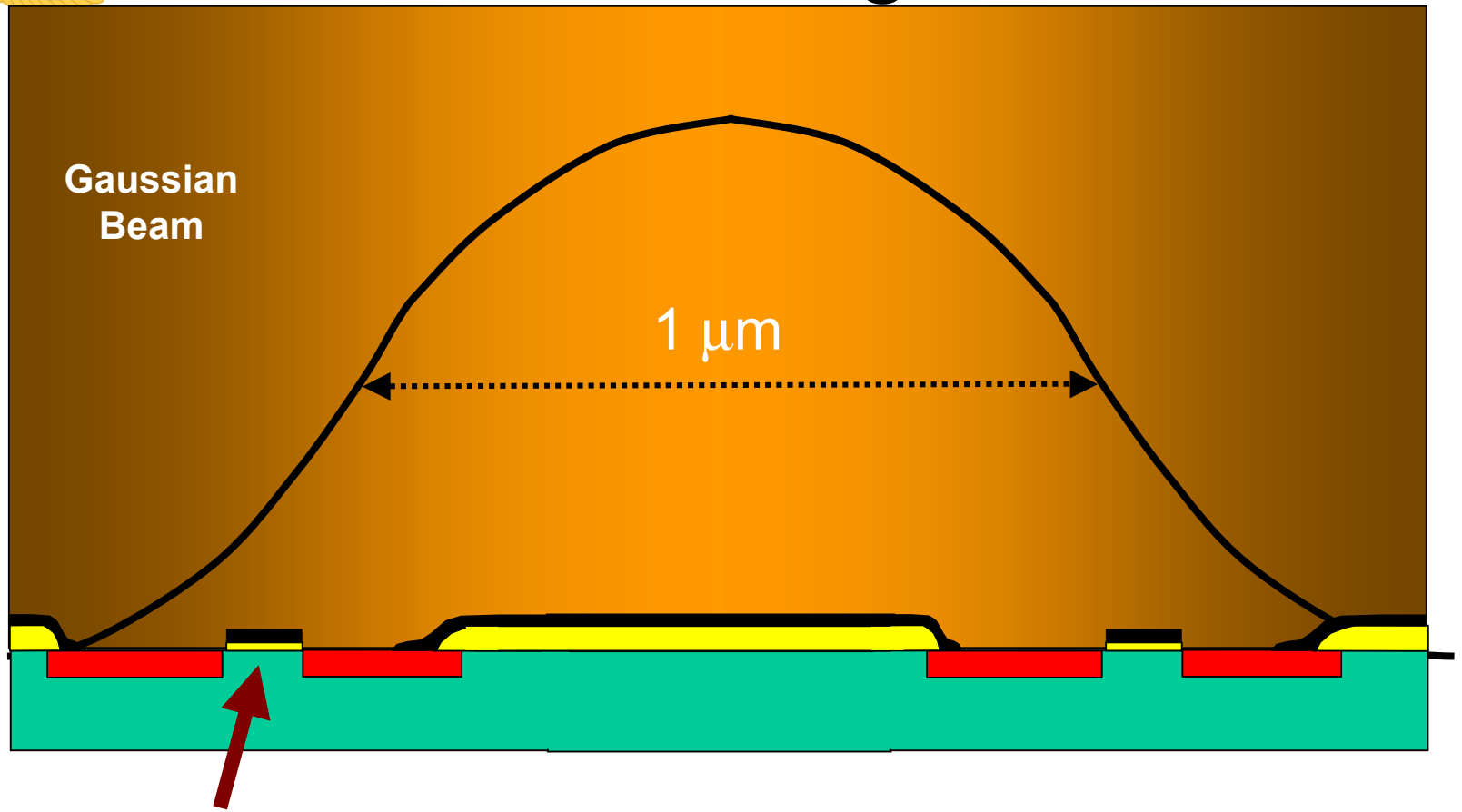
Two Photon Absorption (TPA)

- Substrate may require thinning.



Scaling



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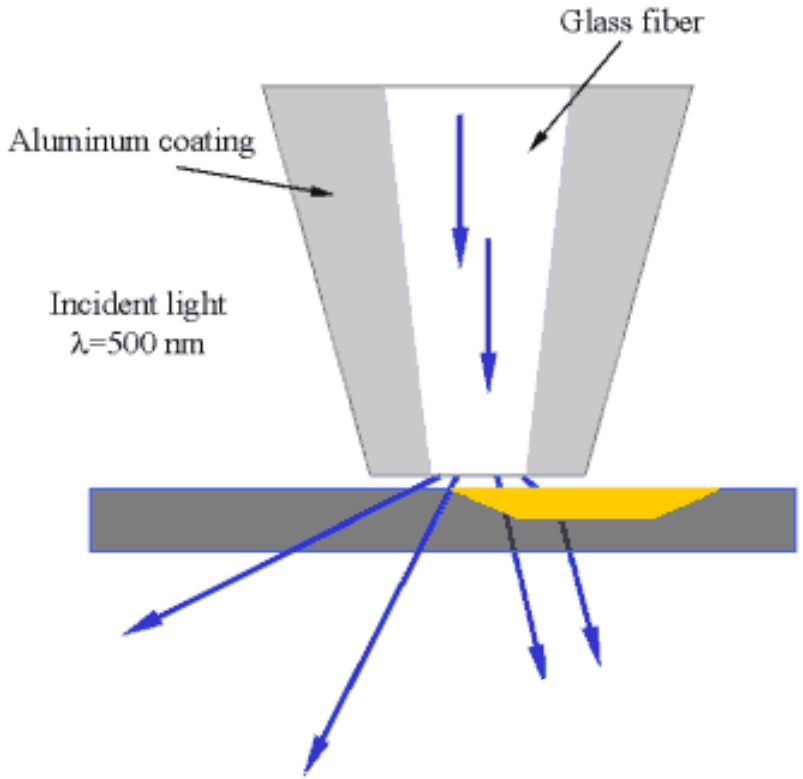
Scaling

Physics Laboratory
Optical Technology Division
NIST National Institute of Standards and Technology
Home | Research Areas | Products and Services | Meetings



Light wavelength (λ) 500 nm	
Probe:	
aperture size (a)	25-100 nm
evanescent field	a/π
tip-sample gap	5-50 nm
Sample:	
feature size	< λ
skin depth	0- ∞
Optics:	
Far-field detector	1-100 mm
Interference effects	λ/4

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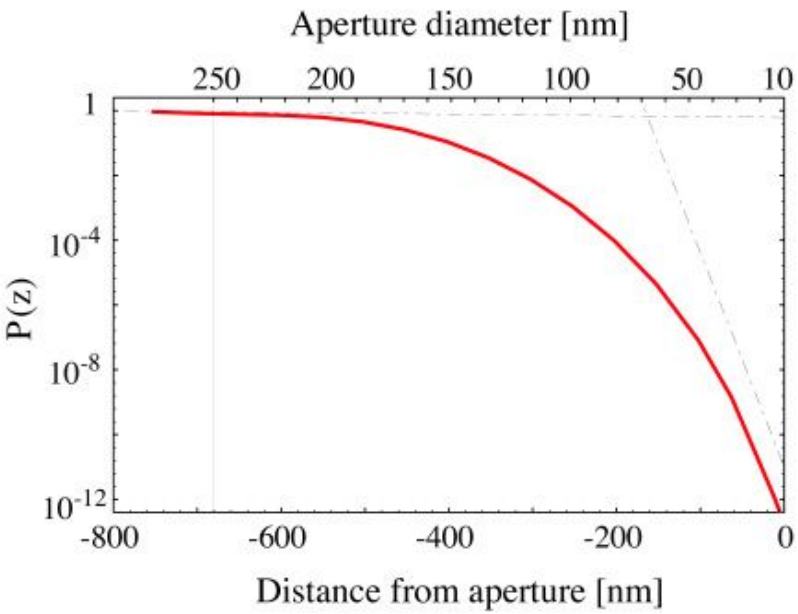
Scaling

Aperture Limits
Pulse Energy

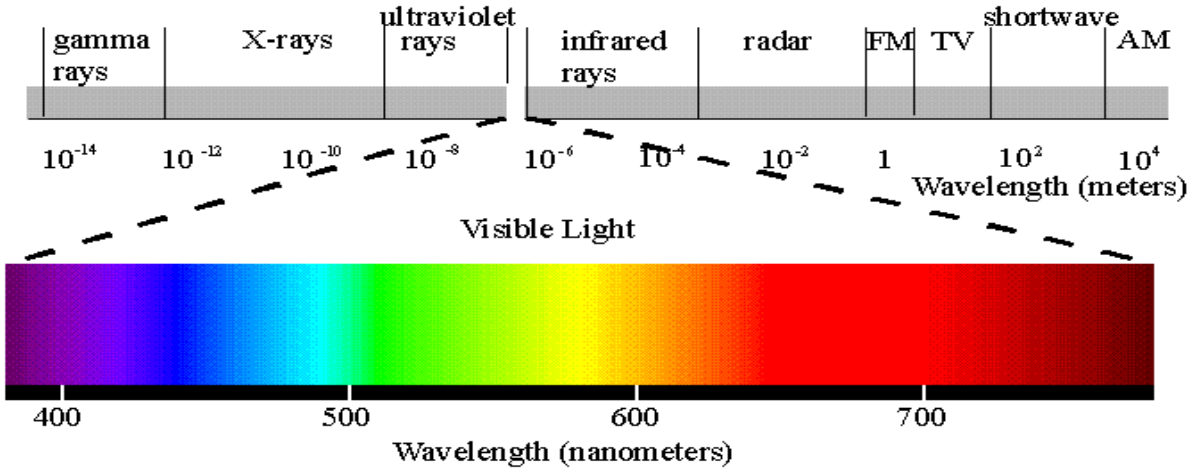
XRAYS



L. Novotny and D. W. Pohl, in *Photons and Local Probes*, NATO ASI Series E, p.21-33, Kluwer Academic, 1995.

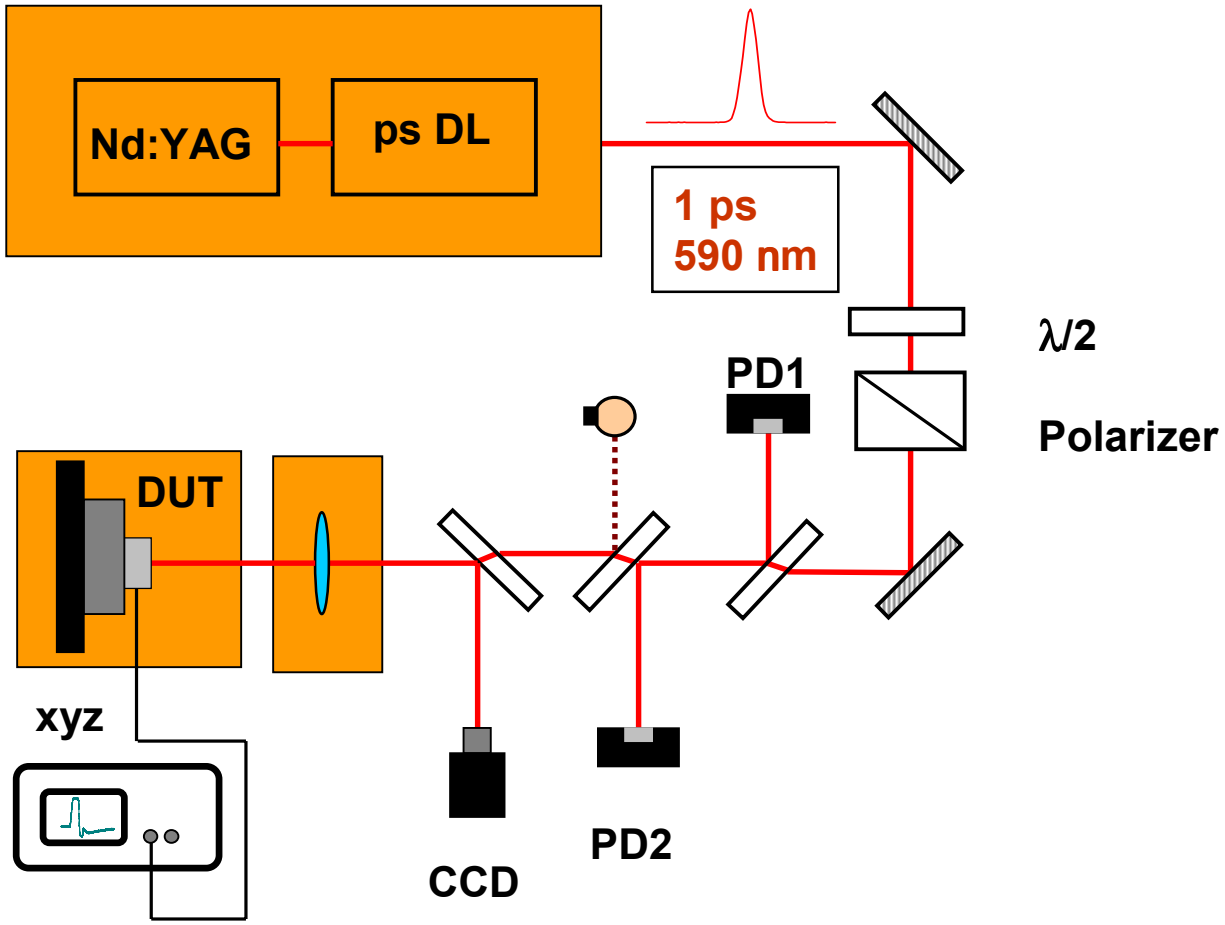
Exotic Materials

- Adjust the wavelength to ensure absorption.



Equipment

1. Laser
2. Stage
3. Focusing Optics



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Compact Laser

- < 100 ps pulse width
- Single shot to 100 MHz
- Pulse Energy = 8 pJ
- Multiple wavelengths
- Not sufficient intensity for TPA

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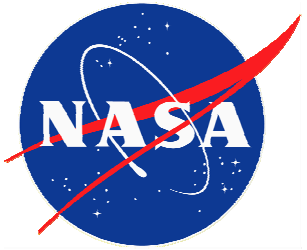
Summary



- **Challenges for the pulsed laser:**
  - Metal
  - Package
  - Scaling
  - Exotic materials
  - Novel devices
  - Equipment